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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/975,444	10/11/2001	Ching-Te Lin	TI-31518	9172

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EXAMINER

PHAM, LONG

ART UNIT PAPER NUMBER

2814

DATE MAILED: 11/04/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/975,444

Applicant(s)

LIN ET AL.

Examiner

Long Pham

Art Unit

2814

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-22 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-22 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on ____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☒ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☒ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) ____.
- 4) ☐ Interview Summary (PTO-413) Paper No(s) ____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. Claims 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over the applicant's admitted prior art (AAPA) of this application in view of Tsai et al. (US '445). ⁴⁴⁶

AAPA teaches a method of fabricating an integrated circuit, comprising the steps of (see figure 1 and the background of the Invention on pages 1 and 2):

forming a dielectric layer over a semiconductor body;

forming a hole or trench or via or contact¹² in said dielectric layer;

depositing a metal layer of liner/barrier material^{14,16} over said dielectric layer including said hole using physical vapor deposition, wherein said step of depositing a metal layer forms an overhang portion at upper portion of said hole and wherein said metal layer comprises a liner/barrier material and a seed layer of copper; and

depositing a metal fillers of tungsten to fill said hole.

AAPA fails to teach that the overhang portion at upper portion of the hole is removed by sputter etch using a low bias after the liner/barrier layer is formed over the hole as recited in present claim 1.

Tsai et al. teach that an overhang at upper portion of a hole is removed by sputter etch after a layer is formed over the hole. See figures 1A-1C and 2A-2C and col. 1, line 10 to col. 4, line 50.

It would have been obvious to one of ordinary skill in the art of making semiconductor devices to remove the overhang portion at the upper portion of the hole by sputter etch after the liner/barrier layer is formed over the hole in the method of AAPA because in doing so the interstices or voids are avoided. See col. 3, lines 30-37.

With respect to claim 7, the use of Ti, TiN, Ta, or TaN is well-known to one of ordinary skill in the art of making semiconductor devices.

AAPA fails to teach that the sputter etch is done at a low voltage of 0 to - 300 volts as recited in present claim 11.

However, it would have been obvious to one of ordinary skill in the art of making semiconductor devices to determine the workable or optimal range for the sputtering bias or voltage through routine experimentation and optimization to obtain optimal or desired device performance because the sputtering bias or voltage is a result-effective variable and there is no evidence indicating that the sputtering bias or voltage is critical or produces any unexpected results and it has been held that it is not inventive to discover the optimum or workable ranges of a result-effective variable within given prior art conditions by routine experimentation. See MPEP 2144.05.

2. Claims 12, 13, 14, 15, and 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over the applicant's admitted prior art (AAPA) of this application in view of Tsai et al. (US '445).

AAPA teaches a method of fabricating an integrated circuit, comprising the steps of (see figure 1 and the background of the Invention on pages 1 and 2):

- forming a dielectric layer over a semiconductor body;
- forming a trench 12 in a first part of said dielectric layer;
- depositing a liner/barrier material 14, 16 over said dielectric layer including said trench using physical vapor deposition;
- depositing a seed layer over said liner/barrier layer; and
- depositing a copper layer over said seed layer.

AAPA fails to teach that the overhang portion is removed by sputter etch using a low bias after the liner/barrier layer and the seed layer are formed over the trench as recited in present claim 12.

Tsai et al. teach that an overhang at upper portion of a hole is removed by sputter etch after a layer is formed over the hole. See figures 1A-1C and 2A-2C and col. 1, line 10 to col. 4, line 50.

It would have been obvious to one of ordinary skill in the art of making semiconductor devices to remove the overhang portion at the upper portion of the hole by sputter etch after the liner/barrier layer and seed layer are formed over the trench in the method of AAPA because in doing so the interstices or voids are avoided. See col. 3, lines 30-37.

AAPA further fails to teach that a via is formed in the dielectric layer as recited in present claim 12.

However, the formation of a via and a trench in a dielectric layer forming a interconnect pattern is well-known to one of ordinary skill in the art of making semiconductor devices.

With respect to claim 15, the use of Ti, TiN, Ta, or TaN is well-known to one of ordinary skill in the art of making semiconductor devices.

AAPA fails to teach that the sputter etch is done at a low voltage of 0 to - 300 volts as recited in present claim 16.

However, it would have been obvious to one of ordinary skill in the art of making semiconductor devices to determine the workable or optimal range for the sputtering bias or voltage through routine experimentation and optimization to obtain optimal or desired device performance because the sputtering bias or voltage is a result-effective variable and there is no evidence indicating that the sputtering bias or voltage is critical or produces any unexpected results and it has been held that it is not inventive to discover the optimum or workable ranges of a result-effective

variable within given prior art conditions by routine experimentation. See MPEP 2144.05.

3. Claims 17, 18, 19, 20, 21, and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over the applicant's admitted prior art (AAPA) of this application in view of Tsai et al. (US '445).

AAPA teaches a method of fabricating an integrated circuit, comprising the steps of (see figure 1 and the background of the Invention on pages 1 and 2):

- forming a pre-metal dielectric (PMD) layer over a semiconductor body;
- forming a contact hole in said PMD layer;
- depositing a liner layer over said PMD layer including in said contact hole using physical vapor deposition, wherein said liner layer has an overhang portion at a top of said contact hole;
- depositing a barrier layer over said liner layer; and
- depositing a metal filler of tungsten or CVD Ti to fill said contact hole.

AAPA fails to teach that the overhang portion is removed by sputter etch using a low bias after the liner layer and the barrier layer are formed over the trench as recited in present claim 18.

Tsai et al. teach that an overhang at upper portion of a hole is removed by sputter etch after a layer is formed over the hole. See figures 1A-1C and 2A-2C and col. 1, line 10 to col. 4, line 50.

It would have been obvious to one of ordinary skill in the art of making semiconductor devices to remove the overhang portion at the upper portion of the hole by sputter etch after the liner layer and barrier layer are formed over the trench in the method of AAPA because in doing so the interstices or voids are avoided. See col. 3, lines 30-37.

With respect to claim 21, the use of Ti as liner layer and TiN as barrier layer are well-known to one of ordinary skill in the art of making semiconductor devices.

AAPA fails to teach that the sputter etch is done at a low voltage of 0 to – 300 volts as recited in present claim 22.

However, it would have been obvious to one of ordinary skill in the art of making semiconductor devices to determine the workable or optimal range for the sputtering bias or voltage through routine experimentation and optimization to obtain optimal or desired device performance because the sputtering bias or voltage is a result-effective variable and there is no evidence indicating that the sputtering bias or voltage is critical or produces any unexpected results and it has been held that it is not inventive to discover the optimum or workable ranges of a result-effective variable within given prior art conditions by routine experimentation. See MPEP 2144.05.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Long Pham whose telephone number is 703-308-1092. The examiner can normally be reached on M-F, 8:30AM-5:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy can be reached on 703-308-4918. The fax phone numbers for the organization where this application or proceeding is assigned are 703-746-4082 for regular communications and 703-746-4082 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

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Long Pham

Primary Examiner

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L. P.

October 30, 2002